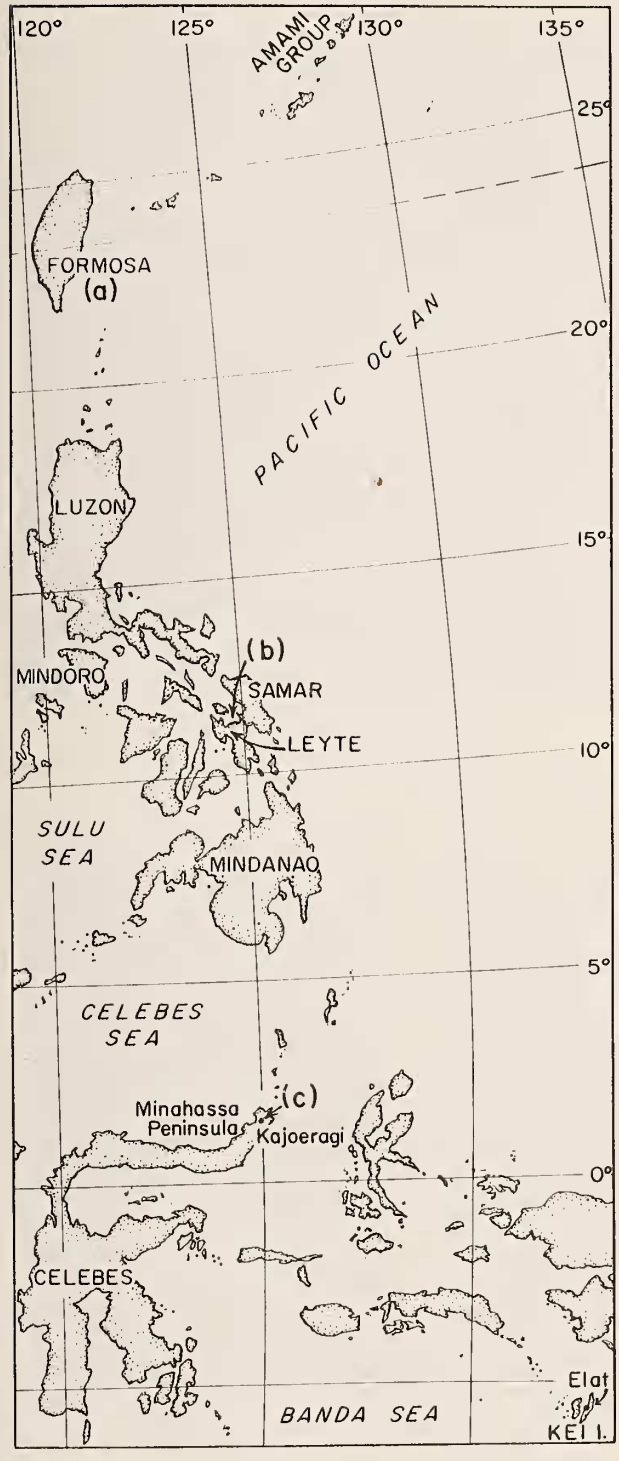

Figure 1: Map showing type localities of:
(a) *Vexillum formosense* (SOWERBY, 1890)
(b) *Vexillum utravis* (MELVILL, 1925)
(c) *Vexillum minahassae* (SCHEPMAN, 1907)

Formosa; ex Habe, Japan). These five specimens seem identical in form with one of mine; other Philippine specimens considered in the present study are shorter and more obese, though still falling within a range of variability that may reasonably be expected. All three species have been considered of rare occurrence, but during the past year V. utravis has been collected in fair numbers at several localities. With the exception of the ANSP shells already mentioned, however, and two specimens of V. utravis misidentified as V. melongena (Lamarck, 1811) in another large collection, I have seen few of them in United States collections other than my own, and they are seldom cited in the literature.

Vexillum formosense was described and figured from three specimens collected off Formosa; Sowerby (1890) compared it with V. caffrum (Linnaeus, 1758), saying its whorls were more rounded and the body whorl much shorter in proportion to the spire. It should be noted here that Sowerby concluded his remarks on his new species by saying, "Three specimens from the Island of Formosa, all similarly marked, and differing but little in form." That he noted any difference in form, however slight, is important, as will be pointed out later. Because of departmental reorganization currently taking place at the British Museum (Natural History), it is, unfortunately, not possible to obtain photographs of Sowerby's holotype, which is presumably at that institution. Consequently, the rather poor type figure from the Journal of the Linnean Society is here reproduced (see Plate 41, Figure 1).

Vexillum minahassae (see Plate 41, Figure 3) was described and figured by Schepman (1907) from fossil or subfossil material collected on Celebes. Apparently, the type lot consisted of at least one complete specimen and several fragments; it is not clear from his discussion whether Schepman had more material than this. One additional example, dredged in mud in 27 meters in the Arafura Sea (Elat, Great Kei Island, Moluccas) was later reported and figured by Schepman (1911, p. 280, Pl. 12, Fig. 7). The color shown in this figure represents the typical faded orange-red color of subfossil specimens, whereas the Philippine shells before me are live-taken, with fresh brown coloring. Although the photograph of the fossil holotype of V. minahassae seems to indicate a color-pattern similar to V. formosense, there is no mention of

color in the original description. Schepman's discussion of the Recent specimen collected on the Siboga Expedition (Plate 41, Figure 4), however, mentions "...the shell is white, with a rather broad orange-brown band below the suture, another at the periphery, only partly visible on the upper whorls and a third at the base, occupying also the canal, though less clearly. The spirals of the base and partly the ribs, especially their upper part, are more or less white."

Vexillum utravis (see Plate 41, Figure 2) was described and figured from a single specimen of unknown locality; at that time Melvill (1925) mentioned its possible relationship to V. formosense, although obviously considering it worthy of specific separation. He further suggested that it might be a hybrid between V. caffrum (Linnaeus, 1758) and V. melongena Lamarck, 1811). The latter two species are compared briefly in J. Cate, 1961.

The morphological differences between Vexillum utravis and V. formosense consist of the relative obesity of V. formosense as compared with the slender shape of V. utravis and the ratio of spire-height to shell-length; this character is extremely variable in V. formosense, though in most of those I have seen the spires are shorter than the last whorl. In typical V. utravis the spire is usually longer than the last whorl or about equal to it. Color is identical in both species, though there is some variability in color-pattern among the slender specimens that have been assigned to V. utravis (see Plate 44, Figure 7). The most important difference between the two seems to be the obesity of V. formosense.

A close relationship between Vexillum formosense and V. minahassae is very apparent, the chief difference between them being the complete reversal of the color-pattern; V. formosense is predominantly brown with white spiral bands, while V. minahassae is mostly white with brown bands. Vexillum formosense is somewhat more obese in this instance also. The sculpturing of both species is very similar, at the same time matching that of the third species, V. utravis. These similarities puzzled me and were the basis for considering my identifications tentative, although each of the three forms seems unquestionably to match the respective descriptions and figures. The surface ornament is evidently the only truly constant character in the morphology of the three species. All three fall within the small vexillid group having the dorsum smooth, axial costae on the ventral surface or on the spire only, the last whorl or two being entirely smooth in adult specimens.

During the summer of 1961, Mr. Dayrit mailed for identification five additional specimens that had been trawled in the same area as the pair of Vexillum minahassae sent a year previously; that is, at Naval, Leyte. It was astonishing to see that of the five shells taken at one time, one specimen appeared to be a good example of V. formosense, though unusually short and obese (and possibly not fully mature), three could be identified as V. minahassae, and the fifth was somewhat intermediate between these two but at the same time with a strong resemblance to the typical V. utravis (see Plate 43, Figures 1-5).

Receipt of this remarkable series led me to request the loan of additional material. Mr. Dayrit very kindly responded with a large group of mixed specimens which had all been trawled in Maqueda Bay during 1961. The box contained five reasonably typical examples of Vexillum minahassae and 32 adult and juvenile examples of V. utravis; no specimens of V. formosense appeared in this shipment. Mr. James E. Norton, also of Manila, sent several shells from his collection that had been taken by divers in from two to five fathoms in three different localities: Baler, Quezon; Masbate; and Batangas Bay. I wish here to express my deep appreciation for the willing cooperation of both gentlemen, as any opinion I might have formed without their additional shells would necessarily have been based on a study-group too small for a fair evaluation of the species.

{It should perhaps be mentioned at this time that the loaned material from both collections contained also several examples of an indeterminate species possessing certain characters common to the other three under discussion. The major part of the Norton shipment, in fact, consisted of shells of this unidentified species, a few of these exhibiting a strong resemblance to Vexillum melongena (Lamarck),

Explanation of Plate 42

Figure 1: *Vexillum formosense* (Sowerby, 1890). Typical specimen resembling ANSP shells from the type locality. Trawled in 20 to 40 fathoms, Tayabas Bay, Quezon, P. I., 1960; ex Cate Collection. Figure 2: *Vexillum formosense* (Sowerby, 1890). Specimen resembling *V. minahassae* (Schepman). Trawled in 20 to 30 fathoms, Naval, Leyte, P. I., 1961; ex Cate Collection. Note similarity in form to *V. formosense* (fig. 1); the only difference is the arrangement of color pattern. Figure 3: *Vexillum formosense* (Sowerby, 1890). Series showing entirely ribbed specimens before starting smooth last whorl.

Figure 1

Figure 2

Figure 3

TAKEO SUSUKI, *photo.*

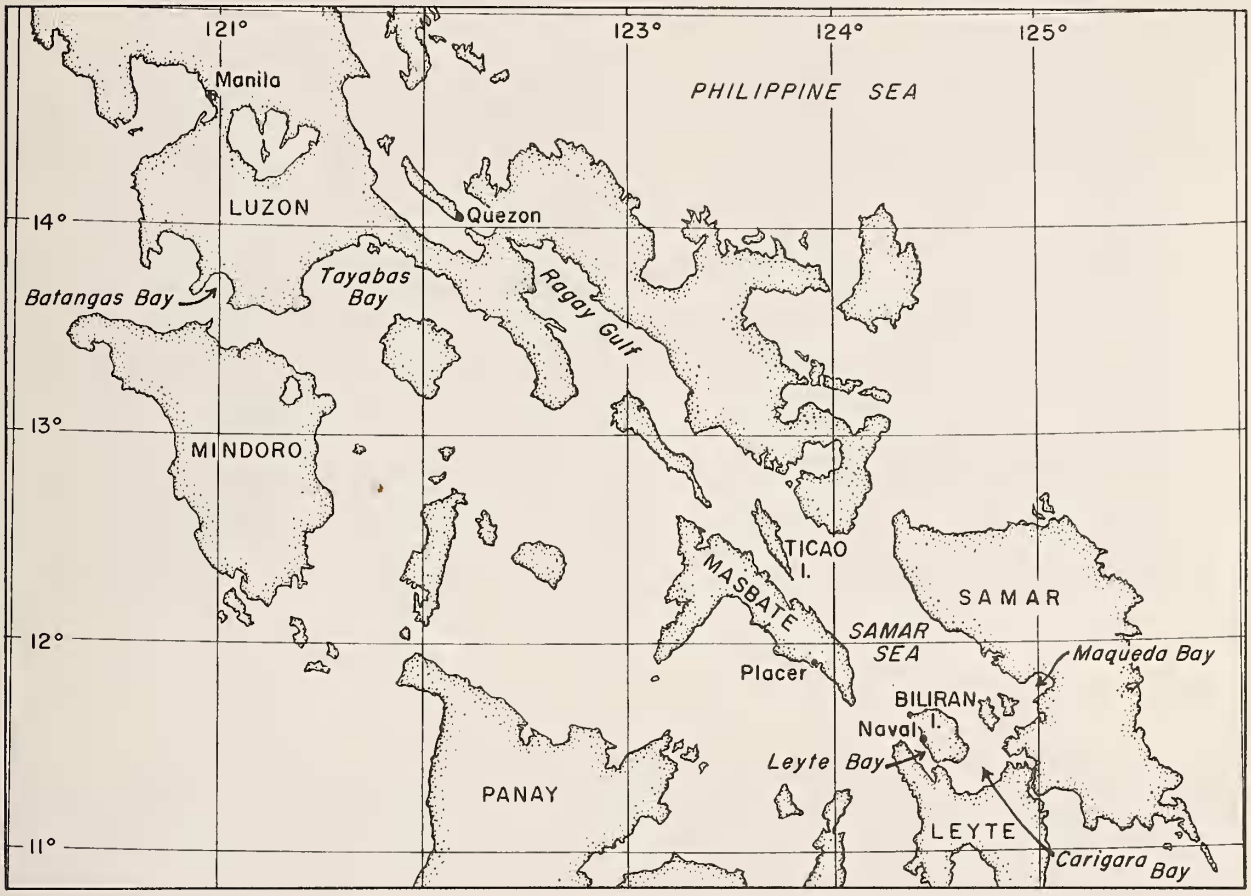

Figure 2: Map showing Philippine collecting areas discussed

although with some differences. The unknown form has been seen from time to time in other collections and in earlier shipments from the Philippines, but its identity has remained in question. It seems to be sufficiently distinct from the V. formosense - utravis - minahassae group to allow for disregarding it as a part of the current study, though it should not be overlooked as possibly belonging to a larger group of species closely related to these. Further work is indicated before it will be possible to place this species in its correct position with relation to other Vexillidae.)

The Philippine localities where examples of the three forms were collected encompass a limited area, within approximately three and one-half degrees of longitude and about two and one-half degrees of latitude, or roughly within a "circle" whose "radius" fluctuates between 90 and 125 miles. Typical specimens of all three species were taken in Carigara Bay, Maqueda Bay, Ragay Gulf, Tayabas Bay, Batangas Bay, Placer, and lastly, the locality where all three forms were taken together, Naval, Leyte (see map, Textfigure 2). According to Mr. Dayrit, the fishermen who have collected these shells do most of their trawling in Carigara or Maqueda Bays, going to the other localities only when the weather is bad or if the catch has been poor in these two places. The nature of the equipment used limits their trawling operations to depths of 20 to 40 fathoms; the three species were all taken at these depths on a mud substrate. Other mollusks collected at the same time in these areas include Tibia fusus (Linnaeus, 1758), T. powisi (Petit, 1842), Ficus gracilis (Sowerby, 1825), various species of Tonna and Turris, and others.

Outside the Philippine area, good examples of Vexillum utravis have been obtained in beach-drift along the shore of Nadi Bay, Fiji, by Mr. A. Jennings. This species seems to occur in reasonably large numbers there, as Mr. Jennings reported (March 1961) having taken approximately 40 dead specimens on one collecting trip. Only one living example has been reported at the present time, however (dredged in 10 feet of water on a weedy mud bottom in Nadi Bay, December 1961), and the Fiji material is mentioned here only to point out the occurrence of the species in at least one area remote from the Philippine Islands (a distance of approximately 4'300 statute miles). Much further study

is needed of the Fiji specimens, and it is hoped that living populations will be discovered there in the near future. It will be of great value if collectors in other areas will report any occurrences, with full collecting data wherever possible, of any of the species illustrated in this paper, in order to help establish the extremes of range for these hitherto little-known forms.

In frequency of occurrence, Vexillum utravis is relatively the most common of the three forms and is collected in fairly large numbers at several locations; it has also been taken in shallower water (two to five fathoms) by divers, as seems not to be the case with either V. formosense or V. minahassae. Vexillum formosense is the second most frequently collected form, and V. minahassae the least often encountered in the areas mentioned (F. Dayrit, personal communication).

Most of the specimens of Vexillum formosense are entirely smooth on the last two whorls, while a few are ribbed ventrally and smooth dorsally as in typical apparently adult V. utravis (see Plate 44, Figures 4-6). The possibility exists that the specimens of V. formosense with completely smooth last whorls represent animals more mature and more fully developed than those whose shells are ribbed only on the ventral surfaces. There is obviously a point where the costae disappear altogether, in this case at approximately the tenth whorl (out of a total of 12). In V. utravis, of which I had a far greater number of specimens to study, the smooth dorsums (that is, the final whorls) seem to occur at about the eighth, ninth, or tenth volutions. A limited few are seen with entirely smooth final whorls, though these seem to be less mature than the smooth examples of V. formosense, as the outer lips are thin and underdeveloped, and the canals are less attenuate. It is possible that these specimens were collected while undergoing a period of growth when the outer lip had not yet thickened; this stage has been observed in specimens of various size-groups in other mitrid species; therefore, the presence of a thin outer lip does not necessarily indicate a completely juvenile specimen.

It is interesting to note that the majority of living specimens of Vexillum utravis I have seen have been collected at precisely the stage of transition from the ribbed to the smooth state. Out of 43 specimens studied, 28 were ribbed on the ventral side and smooth dorsally; nine were ribbed all around and appeared to be juveniles (see Plate 42, Figure 3), and six were entirely smooth on the final whorls though not yet fully mature as to the outer lip. One possible explanation for the imbalance in these statistics might be that the more mature (i.e., smooth-shelled) animals may seek a slightly different environment, such as a greater depth of water, which would be beyond the ordinarily limited trawling-depths of the fishermen who have taken most of the known partly-ribbed specimens. In each of the three species there appears to be a strong tendency to become rather exaggeratedly elongate with advancing maturity. Juveniles frequently appear relatively more obese in proportion to their length, and as the number of whorls increases, the canal becomes far more attenuate than formerly, bringing about a change in the spire-height/shell-length ratio. In other words, as the mollusk grows, the increase in length is more pronounced in the canal than elsewhere, resulting in a relatively shorter spire and a longer body whorl than in younger specimens.

Measurements of shell length, greatest diameter, aperture length, and spire angle were taken for all specimens of each of the three species, but these provided no helpful data except to prove that the proportions and angles of all three forms are as variable as their morphological characters; no other conclusions could be drawn from any of several approaches. The measurements are not included here, as they provide no conclusive data. The only noticeable trend resulting from this part of the study is that, in general, the spire-angle tended to decrease with increase of shell length in Vexillum formosense and V. utravis, while this was not evident in V. minahassae.

Since the Philippine shells were all trawled in depths from 20 to 40 fathoms, and the 1911 Schepman record of Vexillum minahassae indicates a depth of approximately 15 fathoms in the Arafura Sea, it would seem that all three forms live in relatively deep water as a rule and that the mud substrate is an ecological feature common to all. The surface ornament is nearly

Explanation of Plate 43

Vexillum formosense (SOWERBY, 1890)

Series of five specimens collected together at Naval, Leyte, P. I., 1961.

Figure 1 resembles typical but obese *Vexillum formosense* (SOWERBY); Figures 2 to 4 resemble typical *V. minahassae* (SCHEPMAN); Figure 5 shows a tendency toward typical *V. utravis* (MELVILL).

Figure 1

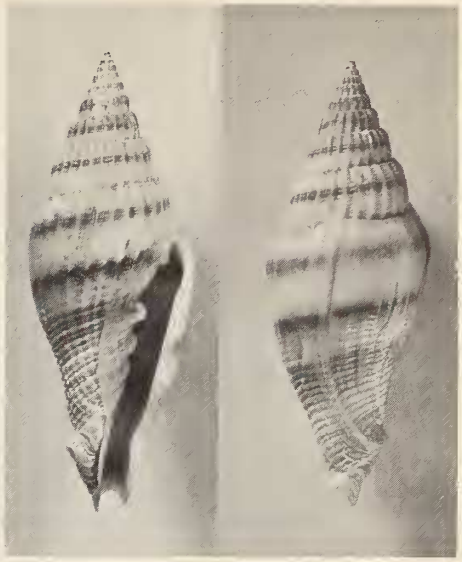

Figure 2

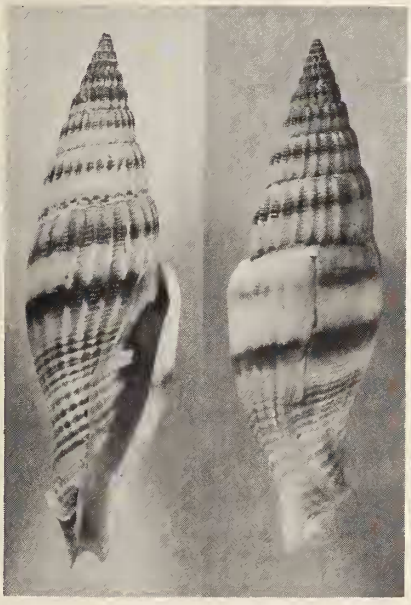

Figure 3

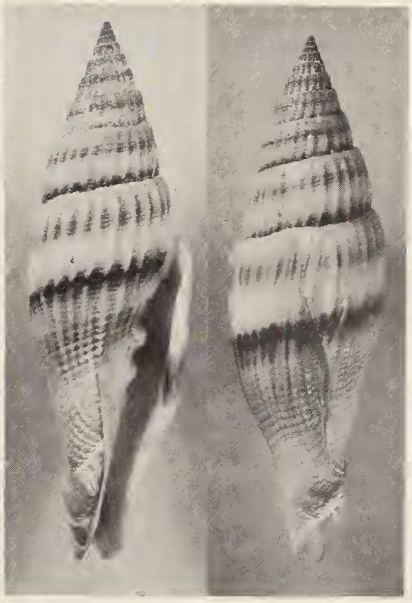

Figure 4

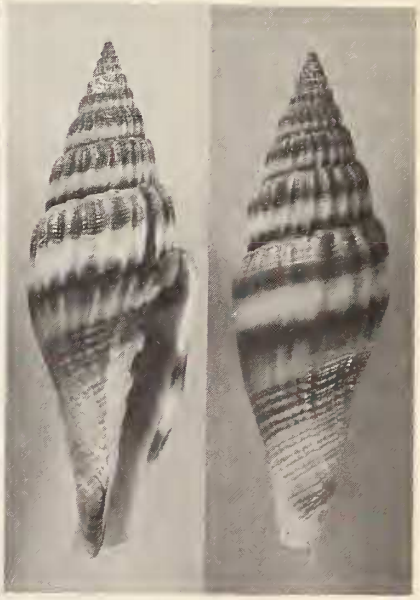

Figure 5

TAKEO SUSUKI, *photo.*